

# Paint and Varnish

# PRODUCTION MANAGER

A TECHNICAL MAGAZINE

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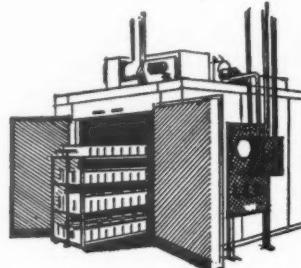


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Solids (%) . . . . .	50±1	Pounds Per Gallon . . . . .	8.42
Butanol (%) . . . . .	30	Compatibilities (By Vol.)	
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Viscosity (G.H.) . . . . .	Y-1	Pet. Nap. (K.B. 70) . . . . .	5-6:1
Color . . . . .	Water White	Min. Sp. (K.B. 35) . . . . .	1-1.3:1
Acid Number (Solids)	5-7		

The Plaskon line of coating resins includes: Pure Alkyds—Modified Alkyds—Ureas—Melamines—Modified Phenolics—Maleics—Ester Gums—Pure Phenolics.

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# PAINT and VARNISH PRODUCTION MANAGER

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## COORDINATION AND COOPERATION IN SYNTHETIC RESIN DEVELOPMENT\*

By HENRY M. ENTERLINE, American Cyanamid Company Research Laboratories

Not too long ago the surface coatings industry relied entirely upon oils and natural resins for its basic means to form a film. It is now history how these were followed by the phenolics, nitro-cellulose, alkyds, ureas, melamines, more recently by the vinyls and silicones, and most currently by the styrenated oils and alkyds. All of these have given to surface coatings some outstandingly improved property, such as more rapid drying and baking, durability, hardness, color, color retention at high temperature, chemical or water resistance. The development of each of these new resins has required the work and time of many people, and invariably each new resin has, at least in its early or effectual exploitation stage, been sponsored by one or a number of large organizations.

We believe it is worth reviewing why and how a surface coatings or resin development laboratory can and does benefit in being part of a large organization. One of the important features of our organization, at least, is the grouping of essential services, which since they work for the whole laboratory, have such equipment and expert personnel that no single laboratory, resin or otherwise, could afford to maintain. The first type of these essential services are those which we use continuously, and include the Analytical Laboratories, the Physical Testing Laboratory, the Patent Division and Library and the Chemical Engineering Division, which operates the Pilot Plant.

A second type of services, such as the Spectrographic, Microscopic, High Pressure Reactions,

Organic and Physical Chemical Research Groups, while they are used by us less often than the first type, nevertheless are readily available. Then there is a third type, with a mutual interest in resins and includes Resin Research, Plastics, Paper, Textile, Leather and Pigments. In addition to the benefits that we get from these groups by interchange of ideas, they provide additional uses, other than surface coatings, for our resins: hot melt coatings or surfacing of paper, crease-proofing or shrinkproofing of textiles and modification of plastics. And who knows but that a resin made for treating textiles may not at some future date be used in surface coatings.

But in order to gain the most benefit from all these services, there must be proper coordination and cooperation. There must be coordination of policy at the higher level of Research, Development, Production and Sales, and cooperation among those individuals actually working in the laboratory. Neither is much use without the other; if the Development and Sales Departments have not decided what they want, cooperation of bench workers is of questionable value.

Coordination is actually achieved by several different types of meetings, as follows: (a) Research—Development meetings are held regularly to consider new materials from within and from outside the Company that offer promise for use in resins, to discuss new ideas and what work will be performed by each. (b) There are Technical Servicemen—Development meetings, at which the laboratory informs the servicemen of new developments and new technical data; the servicemen in turn bring in their problems of

\* Presented before the Detroit Paint and Varnish Club, October, 1948.

complaints, technical difficulties, and new competitive resins they have encountered; there is a general discussion of the raw materials situation, the current sales picture and policy, general resin needs and decisions are made as to the release of new resins. (c) The Steering Committee, consisting of one responsible representative each from the Development, Production, and Sales Divisions, meets regularly to consider the problems of each and recommend to Management the policy on all work.

Cooperation with and by all the various divisions and groups in the laboratory who enter into the research and development of resins is accomplished by conferences and actual visits of personnel. I should like to discuss briefly some of these divisions, their functions, and the capabilities of their cooperation.

The Research Division is divided into a number of groups, among which are High Pressure Reactions, Organic Chemicals, Resins, and General Physical. Some or all of these groups may at some time or other take part in the development of a resin. Their function is primarily research and very often will start with the preparation of new materials, especially nitrogen derivatives in which our Company is particularly interested. After they have performed the initial research on a new resin, the further development and evaluation is carried out by the Surface Coatings Laboratory. However, the Research groups may assist our laboratory in some particular phase of a problem initiated by us.

The Technical Service and Development Division, of which the Surface Coatings Laboratory is part, includes the Plastics Development, Paper Chemicals, Leather Chemicals, Textile Chemicals Laboratories, and others related to the various industries. All of these have an interest in resins and there are frequent meetings and close co-operation among the personnel, so that we get a different approach to resins for uses other than only for surface coatings.

The various chemical analyses made by the Analytical Laboratory are complemented with

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qualitative organic analytical research and spectrographic analyses by the different groups in the laboratory. The infrared absorption spectrum of a substance in the infrared region is a characteristic property, which for purposes of identification has been likened to a finger print distinguishing it from other chemical substances. The absorption spectrogram of a substance (an automatic trace on a recording spectrophotometer) is a plot of the proportion of incident energy transmitted or absorbed by the substance, against wave length or wave numbers. It has been shown that certain atomic linkages have constant characteristics substantially independent of the molecule in which they occur e.g., C-H is constant in interatomic distance, bond energy and bond strength and as a result the C-H linkage has a characteristic infrared absorption frequency. Similarly, O-H, N-H, C=O and many others can be determined. Moreover, the position of the absorption band of e.g., C=O varies as it occurs in an anhydride, ester, aldehyde, or ketone ester. So the various reactive groups of an unknown substance can be determined by comparing its spectrogram with a master sheet having the frequency calibration of the various functional groups. Infrared analysis is an excellent qualitative method and in many cases quantitative data can be given. During the last war, infrared analysis of German tire stock accurately traced the rapid depletion of their rubber and the increasing use of synthetic rubber.

Absorption spectrography in the ultraviolet range, while it has less application than in the visible and infrared regions, is nevertheless of considerable interest in the field of drying oils and fatty acids, since conjugation absorbs strongly at several U.V. frequencies, so that quantitative date can be obtained. Rosin, rosin adducts and hydrogenated resin are also detected by U.V.

Emission spectrography is used for the determination of small amounts of inorganic compounds, e.g., metallic driers. The material being examined is excited by a spark, arc, or flame, causing it to emit its characteristic spectrum, and the presence of certain spectral emission lines permits the recognition of particular atoms. Emission spectrography analyses is rapid and permits the finding of even trace elements and their quantitative estimations. The small amount of silver dissolved in a cup of coffee by merely stirring with a silver spoon was determined by this method as 0.006 ppm.

Spectrum in the visible range being perceptible to the human eye, involves color and therefore is used for colorimetry. Spectrograms can be made both by absorption and reflection, but more use is made of the latter in the examination of colored enamel films. Such a spectrogram will give a permanent record of the color of a film so that after exposure comparisons can be made for yellowing, fading, etc. Or a comparison can be made of two different enamels that appear alike to the eye.

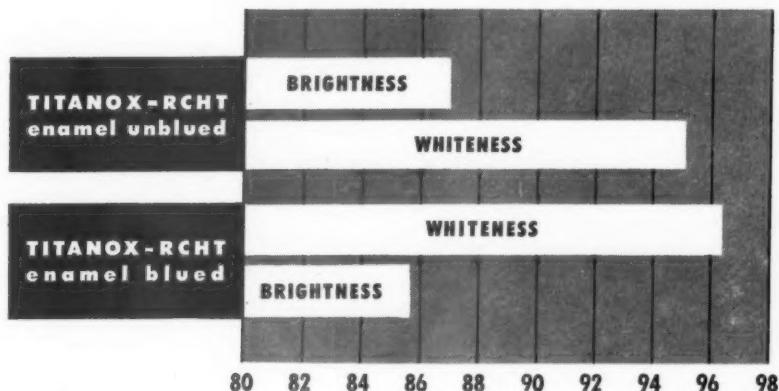
Technical Tips from Titanox

no. 3



**Q. IS HIGH WHITENESS ATTAINABLE WITH  
RUTILE TYPE PIGMENTS?**

**A. YES...ESPECIALLY WITH THE RUTILE TYPES OF TITANOX.**



**T**oday, the rutile types of TITANOX are widely used in white paints and enamels. In some cases, their adoption for white coatings was deterred because of the inherently slight yellowness of rutile.

Whiteness is assured through the proper use of blue or violet toners with rutile type pigments.

The accompanying chart presents the brightness and whiteness of a painter's enamel before and after toning. Pigmentation was 100% TITANOX-RCHT (rutile-calcium pigment) @ 40% pvc. Note how whiteness was increased. (Whiteness here is expressed numerically for comparison, as 100 minus color index where color index is  $\frac{\text{AMBER-BLUE}}{\text{GREEN}} \times 100$  as determined from the Hunter reflectometer.) As whiteness was increased, brightness, being high, was allowably decreased. This high whiteness is bound to be fully effective in the paint after

application, not only on account of the intrinsically high opacity of the pigment, but also because of the further increase in hiding power of the paint as brightness is lowered. Examples of increase in hiding power (complete over black and white) on the order of 10-24 square feet per gallon of paint with each decrease in brightness of 1% are noted.

While TITANOX-RCHT is cited as an example, the balance between brightness and whiteness of coatings made with rutile titanium dioxide—TITANOX-RA—is particularly important in high gloss products which must possess maximum opacity.

We shall be glad to help you achieve the optimum in whiteness and hiding in your product. Call or write our nearest office. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; 104 So. Michigan Ave., Chicago 3, Ill.; 2600 So. Eastern Ave., Los Angeles 22, Calif. Branches in all other principal cities.

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While much of this previous discussion of spectrometry may seem abstract, nevertheless a large amount of fundamental knowledge has been given to the surface coatings industry by these methods, such as the structure and mechanism of oxidation and polymerization of drying oils, a large backlog of data on infrared qualitative organic analyses, etc.

In addition to the above-mentioned apparatus and methods, the laboratory also has available X-ray apparatus, high frequency dielectric equipment, ultrasonic apparatus and electron microscopes. Electron micrographs have been made, by the replica method, of a smooth refrigerator finish and at 30,000 diameters the picture looks like an air photograph of a very mountainous region. Also, the electron microscope has been of great value to the Pigment Division in studying particle size, structure, etc.

Our Surface Coatings Laboratory has as its primary objective the development of new resins but also furnishes technical service for the plants, Sales Department, and customers. This combination of interest, we believe, is essential for two reasons: First, our development program is kept alive and our personnel alert to customers' problems, so that when a decision is made to allow a man or group to concentrate for months or years on a certain problem, it is done not only because the chemistry is intriguing, but because we know the product can be sold when developed. Second, our Sales and field Technical Servicemen have frequent personal contact with the application section of our development laboratory and thus are kept continuously informed of new developments and applications.

The Surface Coatings Laboratory has two logical groups; one for development of resins and one for evaluation and application work. The development group is further divided into work on sales service and plant service, amino, alkyd, and new type resins. While it is not advisable to have similar division in the application group, there is some specialization based on the type of finish such as architectural, furniture, baking, automotive, new type resins, etc. However, such division is very flexible and a large part of the personnel may at one time be working on the same problem. In addition to evaluation tests on new resins, the application group performs plant service and sales service, including special formulations for customers, investigates complaints, and cooperates with the field Technical Servicemen on their problems. The Technical Servicemen while they work out of the sales office spend a certain proportion of their time in the laboratory, approximating one-third each, in the field, in the New York office, and in the laboratory. Most of their time in the laboratory is spent working on problems originating in the field, but they also assist in certain laboratory problems and try to acquire as much knowledge as

possible on the formulation of finishes containing the newest resins.

I believe you will be interested in the following analysis, which we have made of the time distribution for different types of work in the Surface Coatings Laboratory: Sales Service work, which includes special resins, formulation and service for customers, complaints, work on commercial resins, etc., 22 to 30 per cent; Development work including new resins, major modifications of existing resins, conferences, cooperative work with A.S.T.M., Paint and Varnish Production Clubs, etc., 40 to 55 per cent; Plant Service work including placing new resins in production, specifications, test methods or plants, etc., 5 to 10 per cent; Work for other groups, such as Paper, Textile, Research, Pigments, Patent, 5 per cent, and miscellaneous work, including supervisory, clerical, illness, and vacations, 15 per cent. However, as you will know from your own experience, when there are special demands for more than normal sales or plant service work, the development work is usually the first to suffer and there must be proper coordination, if adequate and continuous development work is to be maintained.

The sources and reasons for new resins are: (a) newly available raw materials or adaptation of old ones, (b) replacement of older more expensive or less available raw materials, (c) competitive resins, and (d) special resins for customers or special uses. Of all these, generally only the first one, new materials, will produce a new type resin although occasionally the requirements for a new and special use may cause the development of a new type. New materials, not new chemically, become available for use in resins because of reduction in cost and production in relatively large quantities, e.g., phenol and phthalic anhydride from World War I and pentaerythritol and styrene from World War II. Furthermore, a number of resins for surface coatings have been adaptations and modifications of similar type resins that were previously used in the plastics field, e.g., alkyds, phenolics, ureas, and styrenated products. Completely new type resins were the maleics and silicones. There are an increasing number of new materials from the petroleum industry, some of which will undoubtedly find their way into resins. And we have within our Company new nitrogen derivatives promising for resin work.

The second reason for new resins is replacement for scarce or expensive materials; when glycerol became short, pentaerythritol was used; as the price of linseed oil went up, more and more substitution of other oils was made; and alkyds were made without phthalic anhydride during the war. It is noteworthy, however, that in many cases the replacement material has made a place for itself, and in some instances has proved better than the material it replaced.

Coming now to competitive resins it is obvious that no one organization is endowed with all the

"know-how," and it seems that there is nearly always a competitive resin to be bettered. This may require only modification of an existing resin or an entirely new one, but in either case the advantages of the facilities of a large organization are self evident.

Special resins for customers and special uses generally consist of modifications of an existing commercial resin where the potential volume use justifies the laboratory work involved in making the modification.

The actual development of a new resin may begin in several ways. The Research Division may start with a new raw material made by themselves, or received from outside the Company, and from this make new resins. Or the Development Laboratory may investigate the raw material from either source and prepare a number of resins. Initially, these resins are screened by evaluation tests in clears without pigments, and panels are put on the test fence. Of course, if it is a maleic resin it is tested in varnishes and lacquers. If the resin is a type that will be used with pigments, the remaining resins are evaluated further in enamels. From the data obtained on the most promising resins, a new series is made duplicating the best ones and making others with slight modification to improve some property such as gloss, adhesion, etc. In this screening operation as many as a hundred resins may be made before the desired product is obtained. Several of the best resins are next made on a pre-pilot plant scale, i.e., several gallons, and by further evaluation one resin is selected.

Now pilot plant batches are made by the Chemical Engineering Division, assisted by the personnel who developed the resin, and a complete evaluation made, depending on the type of resin, in varnishes, lacquers and/or enamels with all the commonly used pigments. These tests will determine best drier combinations, grinding characteristics, brushing and spraying characteristics, compatibilities, stability, drying and baking characteristics in film properties. As the same time more exposure panels are made and put on exposure in the Weatherometer, and outside at Stamford and Florida.

If the results of these tests indicate, after co-ordination with the Sales and Production Departments, that the commercial possibilities of the resin are good, a plant batch is scheduled. One or more members of the development staff are present at the plant to supervise and assist in the production of the resin. After successful plant batches are made, the resin is completely evaluated for the Sales and Advertising Departments. A Technical Servicemen-Development meeting is then held (the new resin has undoubtedly already been discussed in previous meetings) and the laboratory presents all the available data. There is a discussion of these results and, of course, no matter how complete the evaluation has been, there are always unanswered questions which must be filled in by further work in the laboratory. Tentative specifications are set up, advertising and sales policy are discussed and definite

**-CH=CH-CH=CH-**

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DRYENE oil upgrader was developed specifically for improving the drying qualities of natural oils such as soya and linseed oils. This oil upgrader introduces a latent system of conjugated double bonds and permits the production of outstanding varnishes and alkyd resin finishes.

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can also be produced. These finishes dry thoroughly and rapidly with excellent print resistance and high gloss; are tough, hard, and resistant to alkalies and water.

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decisions made as to how the resin will be presented to the trade. A release date is then set which will permit time for the gaining of additional laboratory information, the production of a number of plant batches, and the preparation of advertising and sales data.

The development of this new resin may have required anywhere from several months in the case of a resin where a raw material is replaced, to several years for a totally new type resin; for instance, last year when the supply of linseed was short and price was high, it was necessary that we replace the linseed in one of our medium oil length alkyds with other oil. In several months the non-linseed Rezyl Resin 435-1 was developed, put on the market and has become one of the largest selling resins. On the other hand, the development of the totally new urea and melamine resins took several years.

While this discussion so far has been concerned with why and how resins are developed, we realize that customers are the most important factor in the success of a resin. How does the cooperation of our customers affect the development of resins? Certainly, while some quantity of a new resin will always be used, its sale will never reach large

volume unless there is close cooperation between you, who are the users, and the manufacturer. The growth of the urea resins is a good example of this. Interest was wide and immediate, but acceptance and volume were rather slow to materialize. Why was this? Partly because new techniques had to be developed, but mainly because the price was high. Volume probably would not have been reached except that a very few companies decided to upgrade the markets they were in and develop new ones. Hitherto untouched markets were developed but this required a high degree of cooperation between the resin supplier, enamel formulator and the consuming industry. After these pioneers branched out into new fields, their competition was forced to follow and sales volume of urea resins became substantial.

We, in the development of new resins, need all the help and cooperation possible from you, our customers, in passing along your problems and those of your customers, and devising new ways in which surface coating products can be used. We learn from your criticism, either destructive or constructive, and promise you all the help on new products and ideas that our Research and Development Laboratories can give.

## INDUSTRIAL FINISHES AND FINISHING\*

By F. G. WEED and N. P. BECKWITH †

Rinshed-Mason Company

There are two main objectives for the application of organic coatings to industrial products, namely; decoration and/or protection. Decorative requirements based on sales appeal may vary from color harmony through gloss or lustre, smoothness of film, and surface defect concealment. Usually one-coat application will meet the needs of this requirement. However, whenever protection is required the type and system of surface coating to be used is determined largely by the service conditions to be encountered. Conditions may dictate the need for protection against any or all of the following:

1. Atmospheric conditions involving frequent and lengthy exposure to sun, rain and dew, and temperature shock.
2. Salt, both marine carried and that used in cities to combat ice.
3. Galvanic or electrolytic conditions.
4. Air driven or mechanical abrasions of surface.
5. Action of foods, drugs, and chemicals.

When industrial products are to be exposed to any or all of these conditions, the finishing system must be elaborate enough to resist their attacks.

This usually involves a finishing system such as the following:

1. Cleaning and passivation of the metal surface by chemical pre-treatment.
2. Prime (usually corrosion inhibitive) coat.
3. Finish (color) coat.

### I. Surface Preparation

The cause of failure of many protective coatings can usually be found in the lack of care exercised in cleaning the surface to be painted. Since manufacturing operations leave an oil and/or oxide scale on practically all metal surfaces, it is necessary to clean all metal before coating. Vapor degreasing, solvent dip or wipe, or alkali dip may be used to remove oil and loose dirt. Abrasive action, such as sand or shot blasting, wire brushing, etc. may be necessary to remove scale or rust.

However, for good adherence of coatings to the metal and excellent corrosion resistance, special treatments such as bonderizing, parkerizing, or deoxidine coatings are recommended. These have as their main objective the formation of a stable and less reactive coating chemically united with the base metal. This coating not only acts to retard corrosion, but also provides mechanically for greater adhesion of applied paint films. These treatments prevent the spread of rust or battery action when the paint film becomes marred or scratched to such an extent that the metal is exposed.

\* An Address to the First International Technical Congress, Paris, France, October, 1947. Delivered by Capt. Roy W. Hill, Engineer Research and Development Laboratory, Fort Belvoir, Va.

† President and Chief of Automotive Research, respectively.

No one type of treatment will be effective for all commercially used metals. Magnesium and its alloys, in particular, require special and different treatment. The most successful pretreatment for magnesium has been a chromate process.

## II. Application of Organic Coatings

Application of organic coatings to industrial products is accomplished almost exclusively through spraying. Tanks containing liquid protective coating are closed and the paint is forced through lines to and through spray guns. An additional orifice in the spray gun controls the amount of air (also under pressure) which atomizes the paint, distributing it in relatively even film over the surface of the item to be coated.

One of the most successful recent developments in spray application has been electrostatic spraying. Articles to be coated are conveyed between fine wire electrode arrangements. Automatic spray guns are located at the face of the booth to spray the coating material into the booth in a direction roughly parallel to the path of travel of the articles.

Electrostatic deposition is accomplished by charging the fine wire electrode system to a high potential so that an electrostatic field is created between the electrodes and the grounded articles. Atomized particles of coating material sprayed into this field receive a negative charge and are attracted to the line of grounded articles. The attraction in the coating zone is so great that some of the paint particles reverse their direction as much as 180 degrees, coating the back side of the article.

Another application frequently employed for small parts is dipping. Here a recent development is electrostatic detearing, based on the same principle as described above in electrostatic deposition except that it is operated *in reverse*. Tears pending from dipped articles are effectively removed when the still wet item is passed over a grid charged to a high potential. All excess paint is attracted from the dipped item.

## III. Reclamation

In many modern plants finishing procedures include a salvage operation known as reclamation for the oversprayed finishing material. This recovery process is initiated by precipitation of the atomized particles (which have missed the item being sprayed) in a water curtain at the back and bottom of the spray booth. The resulting sludge collects on the surface of a settling tank, and is processed at reduced pressure and temperature to remove water. The solvent balance is restored and the reclaimed material is used either in blends with virgin material or as under coating finishes.

## IV. Curing of Organic Finishes

Protective coatings on industrial items are cured by:

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STEARATE**

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The action of Plymouth No. 101 when used with vehicles of uniform characteristics is always the same. Thus, changes in formulae become unnecessary. Uniform input means uniform output. You can concentrate on one metallic soap in your formulations.

The constant low percentage of moisture and water-soluble salts indicates controlled washing and long, careful drying. Excessive moisture and water-soluble salts mean higher cost to you and a lower quality product for your customer plus changing formulations.

Plymouth No. 101 Aluminum Stearate has excellent suspension properties, improves grinding, minimizes flocculation and seeding, increases body, improves resistance and acts as a flattener. In gloss paints and enamels it has the added property of controlling flow.

*In addition, various types of Plymouth Metallic Soaps are available for specific purposes.*

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Large items, and particularly those finished in lacquer, are air dried. Force drying is employed where industrial schedules require reduced drying time for lacquer finishes and some enamels. Force drying temperatures vary from 70° to 90°C. Baking of synthetic enamel finishes where the change in the coating, to the solid state, is accomplished by polymerization rather than by the absorption of oxygen in the slower drying processes, is accomplished on the most durable industrial items, particularly electrical appliances. Most industrial baking is accomplished in gas, electrical, or steam heated convection ovens. However, the infra red oven is fast replacing the convection oven in many special operations. This is due to the greater flexibility, conservation of space, and lower heat leakage characteristic of infra red baking.

Another method of curing finishes on industrial metal products is the induction oven. The principle involved here is the induction of heat in the metal by passing the object through an electromagnetic field actuated by the high frequency alternating current. Control of heat is somewhat difficult, and this method of heating has found only minor application as yet industrially.

#### V. Automobile Finishing

Automobile finishing processes not only represent one of the most important industrial coating operations, but also involve many combinations of diverse parts and metals. Automotive finishes must excel in decorative effects, since the sales appeal of the modern car depends to a great extent on the eye appeal of the color and lustre of the finish. But, since automobiles are exposed to most of the destructive forces of nature and man, the finish must also offer a maximum of protection. Accordingly, the following discussion of automobile finishing contains most of the examples and principles involved in the finishing of any other industrial product.

##### A. Lacquer System

Slightly more than half of the automobile bodies manufactured in the United States today are finished in the so-called lacquer system. In this system, as in most systems of protective coatings for metallic products, the surface preparation steps described previously are employed; namely, solvent degreasing and bonderizing or granodizing. The next step is the application of approximately .01 mm. (dry film thickness) of an oil based iron oxide primer and baking it dry. The function of this primer is to provide the necessary corrosion inhibition, but it also provides the bond between the metal and the second coat. Primer is applied inside the body and is even slushed around inside the compartments at the bottom of doors.

The second coat is a highly pigmented, oil-based surfacer, spray applied to a film thickness (dry) of approximately .05 mm. to .07 mm., baked dry

and water sanded. This heavy covering fills metal defects and provides a level and smooth surface upon which to build the finish coat.

The finish coat is pigmented lacquer characterized by a high non-oxidizing synthetic resin content as well as one-fourth second or one-half second viscosity nitrocellulose. The lacquer is spray applied in three or four coats. The film is then forced dry (by evaporation of solvents) for 30 minutes at 80°C to 90°C. The lacquer is then wheel polished to a smooth, very highly lustrous finish.

One of the advantages of the lacquer system is the extremely fast drying of the finish. Thus, lacquer particularly lends itself to decorative two-tone color schemes and metallic finishes. These metallic finishes are made by the employment of finely divided deflated aluminum flake pigments in lacquer. The quick set of the finish prevents surface orientation of the aluminum flakes which impart a brilliant metallic appearance to the film. Applied over a curved surface, the effect of metallic finish is extremely attractive. As the angle of incidence of the eye varies over the curved surface, the color of the finish varies particularly in depth.

A recent trend has been the so-called "metalli-chrome" or "glamour" finishes. These finishes couple the metallic finish described above with an added effect caused by the incorporation of ferric hydrate pigments characterized by weak hiding power. The resulting films are semi-transparent, the remarkable "depth" of metalli-chrome or glamour finishes being due to the reflection from the aluminum flakes at varying depths in the films.

Other advantages of the lacquer finish include the ease of repair (even years after application) and the extreme durability under exterior exposure.

##### B. Enamel System

A large number of automobile bodies are finished in enamel. Here the first coat is normally a combination primer surfacer, synthetic resin based, and combining corrosion inhibition with surfacing qualities. This primer surfacer is spray applied to a film thickness (dry) about .025 mm. and is baked dry and water sanded.

In many cases, a second coat of sealer consisting of a neutral colored synthetic enamel is spray applied, baked dry, and water sanded. Reclaimed enamel obtained in the process described previously frequently is employed as sealer.

The finish coat, synthetic enamel, is spray applied to a thickness of approximately .025 mm. (dry film) and baked 30 minutes at 120°C. The resulting finish is characterized by a high initial gloss or lustre. The synthetic enamel employed is made by pigmenting semi-oxidizing synthetic resins.

##### C. Sheet Metal

Sheet metal such as hoods and fenders are normally finished in a two-coat operation. A high bake primer is normally applied, either

through a dipping or a flowing operation. The second or finish coat is applied as described under lacquer and enamel systems. Color control of the finish is elaborately checked to ensure absolute conformity to the shades employed over the car.

#### D. Wheel Enamels

Automobile wheels are universally finished in synthetic enamel formulated with semi-oxidizing synthetic resins. Toughness of film is one of the most important requirements since the finish must withstand more than normal abrasion from flying gravel and dirt. Almost all manufacturers employ automatic spraying devices. Note that the wheel is spinning while being automatically sprayed. The water curtain catches overspray and prevents excessive gumming of the booth. The finish on most automobile wheels is baked in infra red ovens.

#### E. Sound Deadener

Increasing use is being made of a sound-deadening material under hoods and fenders. This deadener is made of silica, asphalt, and asbestos shorts. It is applied by a spray gun with a large orifice (approximately 1 cm.) in coatings of approximately one-half cm. thick. The deadener has the additional purpose of mechanically inhibiting corrosion.

#### F. Chassis Enamels

The under carriage or frame of the automobile is not exposed to sun, but is attacked by all other forces of deterioration, most powerful of which is corrosion. Accordingly, the enamel used on chassis parts is especially formulated to inhibit corrosion, generally by mechanical insulation. Chassis enamels are usually bituminous resin based, are black, and air dry generally by the evaporation of solvents.

#### G. Spot Repair and Touch Up

The materials employed for spot repair and touch-up are the same as the finish lacquer in the lacquer system of automobile finishing.

For enamel finish it is not practical to subject an assembled automobile to high baking temperature. Lower and localized heat must be applied to the spots repaired or touched up. Accordingly, the enamels used for spot repair and touch-up are formulated to bake dry under relatively low time-temperature schedules. The synthetic enamels employed for this purpose are carefully compounded with oxidizing resin vehicles, and the pigment combination balanced to give the same color as the rest of the finish which was baked at a longer, higher time temperature schedule.

#### VI. Refinishing

It has been estimated that an average automobile is repainted six times, in its life. This represents a tremendous outlet for automobile finishes. However, since most refinishing is accomplished in small relatively unequipped shops, refinishing materials must be particularly designed to dry without heat. Oxidizing synthetic

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resins are employed as vehicles for refinishing enamels. These enamels will dry tack-free in four hours, and print-free overnight. Lacquers are used extensively in refinishing, the fast-drying finishes being particularly adapted to touch-up and spot repair of the finish of an automobile coated with the lacquer system. Highly pigmented, lacquer-based, quick-drying, primer surfacers are widely used as under coats in refinishing.

Vans and trailers, too large for normal convection baking equipment, are usually finished in air dry systems using quick-drying synthetic enamels such as those designed for refinishing. Synthetic primer surfacer made with oxidizing synthetic resins is used for undercoats.

#### VII. Refrigerator Finishes

The protective coatings applied to refrigerators and other electrical household appliances must withstand a wide range of exposure conditions, among which the following are important:

- A. Marring, chipping, and scuffing.
- B. Alcohol and fruit juice attacks.
- C. Food greases and oils.
- D. High humidity.
- E. Thermal shock, particularly exposure to high heat.
- F. Bleaching action of sunlight, as well as yellowing effect caused by absence of light.

After the usual metal preparation, a two-coat system of synthetic enamel is applied to refrigerators. The primer coat, consisting of an alkyd resin enamel pigmented with titanium dioxide and zinc oxide (for film length and humidity resistance), is spray applied to a film thickness of approximately .02 mm., and baked dry for half an hour at 145°C.

The primer coat is then sanded to remove surface defects and provide "tooth" for the finish coat. The latter is then spray applied to a film thickness (dry) of approximately .04 mm. and baked one-half hour at 145°C. The finish enamel is formulated with a combination of semi-oxidizing and non-oxidizing alkyd resins, modified with melamine and urea-formaldehyde resins to impart toughness and hardness. Titanium dioxide is employed as the pigment due to its high degree of opacity and whiteness of color.

Reclamation of both primer and finish overspray materials is extensively practiced, the reclaimed product being blended with its corresponding virgin material.

#### VIII. Washing Machine Finishes

Washing machines are finished in systems closely resembling those employed for refrigerators and the coatings applied are similarly designed except that higher melamine and urea formaldehyde resin proportions are used in the vehicles to increase the alkali resistance of the finish. Baking schedules are shorter and at a higher temperature than for refrigerators.

#### IX. Electric, Gas, and Oil Stove Finishes

For stoves a two-coat system is employed. The primer is a synthetic enamel with a semi-oxidizing alkyd resin vehicle. The finish is formulated with methacrylate resin modified with chlorinated diphenyl as plasticizer. The chief characteristic of this finish is the extremely high heat resistance, exposure to temperatures up to 260°C. having little effect on the finish. The finish is almost as hard as porcelain, and is very much cheaper.

Some parts, especially oven doors, are being finished in one coat of alkyd modified silicone resin-type enamel, baked dry at 200°C. This finish is still not as costly as porcelain, and withstands heats of 260°C. almost indefinitely without change.

#### X. Space Heater Finishes

Most oil-burning space heaters are finished in a one-coat system. The synthetic enamel used is designed to withstand high heats for extended periods of time. The resin component is predominately alkyd, but is modified with melamine and urea formaldehyde resins. Considerable quantities of finely divided and deflated aluminum flake pigment are used to impart a metallic appearance and aid in metal defect concealment. Color of the finish is usually brown.

Many space heaters are wrinkle finished. The material is an enamel in which the vehicle is a tung oil varnish. Excessive surface drier is added. This finish, sprayed on in a heavy coating, is baked dry. The surface seals over first, and attractive wrinkle finishes result. Wrinkle finish is made in nearly every shade and has high degree capacity for concealing surface defects.

Still another type of coating employed on space heaters, as well as on reading lamp bases, laboratory instruments, etc., is the hammer finish. This finish is obtained by spraying the item to be coated with a synthetic enamel relatively highly pigmented with deflated aluminum flake. The wet film is allowed to "set up" one or two minutes. Then a volatile thinner is misted over the enamel with very low air pressure in a spray gun. The resulting finish is baked dry. The effect secured, a simulation of hammer dents in the surface, has a good eye-appealing effect, and considerable surface defect hiding is obtained.

#### XI. Water Heaters

Water heaters of the gas or electric type are finished with one double coat of white synthetic enamel, spray applied and baked dry by infrared lights. Water heater bases are sprayed and conveyed through an infrared oven.

#### XII. Conclusion

In the foregoing, we have presented a cross section view of the materials and methods employed in the protective and decorative coating of common industrial products. It is to be emphasized that the materials and processes described are generalizations of those employed by many competing manufacturers in each case.

Each manufacturer varies his finishing materials, and processes according to his own evaluations, and the limitations imposed by cost, building space, and availability of materials.

Formulations of finishing systems and component costs of the systems are carefully checked by the protective coating manufacturer who employs a large staff of laboratory technicians to conduct and evaluate accelerated and service tests on the materials. As a typical example, no finish for automobiles is supplied to the car maker until it has proved to be entirely satisfactory under one year of tropical (accelerated) exposure. Through such extensive technical efforts modern paint companies are making tremendous advances toward providing the perfect organic coatings for industrial products.

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## TECHNOLOGY

**PETROLEUM DRYING OILS FOR INKS.** The properties of a number of commercially available oils and resins derived from petroleum are discussed. These products have low acid numbers which is considered advantageous in respect to reducing livering difficulties, reducing pigment fading and greater ability to handle chemically basic pigments. Some of the products show good anti-skimming properties, low saponification values, high water and alkali resistance, improved hardness and increased surface gloss of some vehicles to which they are added, and show promise in printing inks. F. J. Smith and R. J. Lee. Am. Ink Maker 25, No. 12, 29, 31, 33 (December, 1947); 26, No. 1, 35, 37, 39, 49 (January, 1948).

**AIRCRAFT FINISHES.** This paper deals with the specifications, requirements, properties and performance characteristics of finishes for aircraft. The requirements of these finishes are enumerated, the types of surfaces to be protected (wood, supported fabric, unsupported fabric, metal), pretreatment methods for metal surfaces, specifications and formulations of the various finishes used, proprietary finishes and recent developments in the field are discussed. The assessment methods for performance, rate of drying, and determination of toughness, hardness, adhesion, and tautness are taken up. R. J. Ledwith. Jour. Oil & Colour Chemists Assn. 30, 503-518 (1947).

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# CHANNEL AND FURNACE CARBON BLACKS\*

By GEORGE J. DUFFY, Godfrey L. Cabot, Inc.

There is a wide variety of black pigments, of course, so I believe a definition of the term carbon black is an essential first step. Let us start with the period when commercial, large-scale production was begun. This would be about 1870, when a plant was erected at New Cumberland, West Virginia, and a carbon black was made for the paint and ink business. There, natural gas, which is largely methane with small amounts of propane, was burned to produce small flames—the flames were then impinged on either soapstone slabs or iron pans to cause a deposit of carbon black. The product corresponded roughly to the kind of carbon black now used for news inks and for low-cost automotive frame paints and industrials. Today, these grades sell for about eight cents per pound. In 1875, this black sold for prices between \$3.00 and \$5.00 per pound.

## Channel Black

Black pigment so produced—by partial combustion of natural gas, with the flames impinged on a relatively cool depositing and collecting surface—is now known as Channel Black. Another name, widely used for the same process and product, was Gas Black.

There is no need to dwell on the subsequent development of the carbon black industry. You might be interested to know, however, that during the latter 1920's, there was a wholesale migration of the production phase of the industry to the Texas Panhandle, due to the discovery of cheap and plentiful supplies of natural gas in that area.

By this period, practically all carbon black was produced by the channel process, which is the same in principle as the original West Virginia operations. However, in place of soapstone slabs, or iron pans, the flames are now impinged on iron channels. This operation gave rise to the name Channel Black. Today, then, there are three names applied to the same product: Carbon Black, Gas Black, and Channel Black.

A modern channel plant consists of rows of metal sheds, each about 10 feet wide and 100 feet long. These sheds are set parallel to each other about two feet apart, and there may be from ten to forty set side by side. An identical row of sheds, or "burner houses," is set up across a 12-foot alley. Down through this alley run the screw conveyors which carry the black to a packing house where it is bolted to remove grit, agitated to the desired weight density, and packed in bags or stored in bulk.

There is a manifold arrangement to distribute

natural gas uniformly to each shed and to the burner pipes within each shed. The burner pipes are pierced at intervals of two to five inches, and steatite tips are inserted to control the size and shape of the flame. These tips may be from 2 inches to about 4½ inches below the channels where the flame is impinged. In a standard burner shed there will be approximately 3,300 of these tips, each of which sustains one-flame.

The channels are 8-inch channel iron, arranged lengthwise in the shed, flat side down, with a few inches between them. They are rigidly tied together to form the "channel table." This "table" is set on wheels and rails and is slowly reciprocated so that the deposit of black is drawn over a scraper, falls through a hopper into the building-conveyor, and thence along to the packing house.

The quality of the black manufactured in a unit is controlled by several factors:

1. Quality of gas supplied.
2. Type of tip used.
3. Tip spacing (one from another).
4. Tip distance below the channel.
5. Amount of air admitted at the bottom of the shed.
6. Amount of combustion products allowed egress at top of shed.

All manner of flame patterns are produced by variations in tip design—from round flames to flat or sheet flames. It is an elemental rule of the carbon black business, however, that increasing blackness of the product means a decreasing yield of carbon black from a given quantity of gas.

Channel carbons, as produced normally, always contain about five per cent by weight of chemically bound gas, which is largely oxygen, with some hydrogen. This gas is on the surface of the black and serves an excellent purpose, since it enhances the wetting of the black and stabilizes the resulting dispersion.

In fact, so beneficial is this volatile to the performance of blacks that in the production of some grades, special arrangements are employed to extend the normal five per cent volatile up to twelve or fifteen per cent. For example, a low-cost channel black, such as is employed in news inks or low-cost paints, contains five per cent volatile. This is sufficient for the uses mentioned above. But then, our chemist wants to formulate an offset ink with a bodied oil and high loading of carbon black. He finds that the black he used in news ink cannot be heavily loaded in bodied oil because at eighteen or twenty per cent loading, his ink is a dry paste. By substituting a carbon black which contains twelve to thirteen per cent of volatile, the chemist can load up to thirty-five

\* Presented before the Kansas City Paint and Varnish Production Club, February 10, 1949.

per cent black, which gives the necessary strength and opacity, while maintaining a body sufficiently soft to allow milling and printing.

The same effect of volatile is observed in the higher-priced, more intense paint blacks. As produced in the normal channel process, these grades are extremely difficult to wet and disperse. When dispersion is effected, there is very often a livering action, or "seeding," to contend with. The very black color carbons, therefore, are treated by a combustion process to a volatile content to twelve to fourteen per cent.

This high volatile, which is in the form of a gas blanket around each particle, produces a surface that is readily wetted by resinous materials, maintains a usable viscosity on storage, and exhibits very reduced affinity for drier metals.

Channel carbon blacks range in particle size from 0.006 microns to 0.032 microns. They all have a minimum of four to five per cent by weight of absorbed gas content and some are as high as sixteen per cent in volatile content.

By present techniques, the largest particle size channel carbons may be produced at a yield of slightly over two pounds from each MCF of natural gas. These blacks are the grayest and lowest oil absorption channel black, having oil absorption about 75 lbs./100 lbs. of black by the Gardner method.

The High Color Carbons are very much lower in yield than the grayer types—producing about one-third of a pound from MCF of gas. It is readily apparent that if gas costs 6.0 cents per MCF, the gas cost per pound to produce a low color black would be three cents at a two-pound yield, while a High Color Black would carry a gas cost of eighteen cents per pound.

When, in addition, we realize that pounds of production vary directly with yield, the fixed costs of plant operation must be heavily loaded on a low-yield black, so that the price differential between Low Color and High Color black is a direct reflection of yield.

#### Summary of channel black properties:

Ranging in yield	1/3 to 2 lbs.
Ranging in particle size	0.006 to 0.032 microns
Ranging in oil absorption	75 to 135 lbs.—Gardner method
pH	2.5 to 5.5

Before leaving the channel carbons, I should add that they all have an acid pH. If calcined to remove their volatile content, they show a basic pH. and go up to 9.0 when thoroughly calcined.

As to how channel carbons vary in their properties, it is relatively easy to know what reaction to expect, if we simply keep in mind that decreasing particle size means increasing color, increasing oil absorption, and increasing price.

The same rule applies to the Furnace Blacks which we will discuss in a moment. The Furnace Blacks have larger particle size than the Channel Blacks—therefore, they are less black, lower in oil absorption, and generally lower in price.

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#### Furnace Carbons

The furnace-type carbons have been known for many years but not until World War II was there a large production capacity established. This was due to the necessity of having a large particle size black to reinforce GR-S, the government standard synthetic rubber. Channel carbons were hard to process in GR-S, and GR-S tires reinforced with channel carbon developed so much heat that they rapidly blew out.

Furnace carbon is also called carbon black, since it is similar to channel carbon in sharing the same raw material—natural gas. Furnace carbon plants consist of a burner box, which is so designed as to admit measured quantities of gas and air through pipes, slot, or holes in one face. A sufficient quantity of air is admitted to burn a portion of the gas.

The heat from this combustion "cracks" the balance of the gas and releases carbon. This carbon is carried along by the gaseous combustion products out of the burner box into a large horizontal flue where it is joined by the exhaust products of several burner boxes.

The flue conducts the Furnace Black and the gases to the bottom of a vertical tower. This tower is called the spray cooler, and as the black rises up through here, it is sprayed with jets of water, which drops its temperature from about 2000 F. to about 800 F. From the spray cooler, the black and gases go over to a Cottrell Precipitator where the black particles are aggregated into larger aggregates. Out of the Cottrell, the black is carried into cyclone bolters, where centrifugal force is used to throw the black out of the gas stream. The gas passes out through a stack, and the black drops down into a screw conveyor. From this point on, Furnace Black, is handled very similarly to channel black in further bolting to remove any grit, and in packaging.

The quality of black produced in a furnace plant is governed by the type of gas burned, the ratio of air to gas employed, and the contact time, or combustion period in the burner box.

Furnace Black differs from Channel Black in three important characteristics—it has larger particle size, practically no content of chemically bound gas, and an alkaline pH, usually about 9.0. However, although the original furnace carbons had particle size of about 0.06 microns, the present techniques can produce furnace blacks with particle size about equal to the coarsest channel blacks, or about 0.040 microns. If such a furnace carbon is oxidized to produce a volatile content of five per cent, it would then have a pH of about five and would be partially indistinguishable from a channel carbon. This has been done on an experimental basis.

Another type of black is now being produced

in the furnaces, but here liquid hydrocarbon is employed as the fuel, or raw material, in place of gas. These oil blacks are a cross between true lampblacks and a furnace black. If we wish, we can call the original furnace carbons "Low Oil Adsorption Furnace Blacks" since this is one of their outstanding properties. Then the Furnace Blacks made with liquid hydrocarbons are distinguished as "High Oil Adsorption Furnace Blacks."

"High Oil Adsorption Furnace Blacks" are similar to lampblacks in all respects except one—lampblacks have acid pH (about 5) while "High Oil Adsorption Furnace Blacks" are alkaline pH (about 8).

"High Oil Adsorption Furnace Blacks" are very much cheaper than the comparable lampblacks they so closely resemble. This is due to their continuous process of production compared with the intermittent method used in the lampblack industry. Because these blacks made from liquid hydrocarbons are so similar to lampblacks in easy-wetting, resistance to floating, and clean blue tone, their economy is rapidly carrying them into many fields.

Now just a word about pelletized, or dustless, forms of black. First, I should like to correct the impression held by a surprising number of people, that there is a binding medium employed to hold these pellets together. Except for a few special non-pigment uses, carbon black pellets consist of 100 per cent carbon black. There are two methods of forming these pellets—the dry process and the wet process.

In the dry process, fluffy carbon black as it comes into the packing house is agitated, or stirred, to remove the occluded air. This "agitated" black is fed into a slowly revolving drum, about six feet in diameter and ten feet long. At a given moment, there will be about a ton of black in the drum. The weight of this black, plus the rolling action, compacts the material and shapes it into spheres. The high surface attraction of one carbon black particle for another holds the pellet together. Size, hardness, and density of the pellets are controlled by the rate of in-put, depth of the charge, and speed of rotation. It is a continuous process, with fluffy black going in one end and pellets riding up over a collar and out the discharge end.

In the wet process, fluffy black is fed into a trough and carried along by a sort of screw conveyor consisting of pins set in a shaft along a spiral plane. As the black is rolled and tumbled along, it is wet by a water spray. The trough is about nine inches in diameter and six to ten feet long. When the black reaches the end of this trough, it is shaped into rough spheres, containing 50 to 75 per cent of water.

These damp spheres then drop into a tubular rotating drier and are here polished to true spherical shape and the water removed by the heat. The wet process is capable of producing very good-



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looking pellets from almost all types of black, while the dry process will not make good pellets from some types—as for example, from furnace carbons produced from a liquid hydrocarbon fuel.

Pellet blacks enjoy many advantages, and in some cases, disadvantages. They exhibit less dusting, and therefore, there is less waste and contamination. Pellet blacks store in one-half to one-third the space required for an equal weight of fluffy black and having less exposed surface, they are not so quick to pick up moisture. In addition, there is a lower freight rate on shipments of pellet black.

From the Texas Panhandle to Kansas City, the base freight rate on fluffy black is \$1.09 per hundredweight. On pellet black, the rate is 92 cents per hundredweight. On a 30,000-pound carload, this is a difference of something over \$50.00.

Pellet blacks wet more rapidly than fluffy forms, because they contain less occluded air. Also, pellets usually produce a lower viscosity paste and can therefore be ground at higher black-to-vehicle ratios. Pellets have not yet developed to the point where they can be successfully ground on roller mills, with the exception of one grade produced for litho and offset inks. Ball or pebble mills are required to disperse the pellets in most applications.

Pellet blacks are shipped to the rubber industry in bulk, in specially designed tank cars which carry from 60,000 to 80,000 pounds. This is the most economical method of all, where large quantities of black are used, since mechanical loading and unloading can be employed.

The original types of furnace black were produced with a yield about three times that of the most economical channel carbons, so that in spite of the much higher capital cost of a furnace plant, the black sold for a very low price. Development work aimed at making furnace carbons with smaller particle size, and therefore improved color and strength, has so far indicated that as we approach the particle size and color of channel carbons with furnace production, we approach equivalent yields and so lose the economic advantages.

However, if in five years the furnace technique can become competitive with the 70-year old impingement process, there is hope that in the future, the furnace plants will supply the answer to rising gas costs, and improved types of black. Some of the methods already under intensive study are pre-heating the fuel gas, enriching the gas with cheap petroleum residues, and improving collection techniques. The Cottrell Precipitator is very efficient for large particle size blacks—almost one hundred per cent. But for the finer grades, approaching channel carbons, the Cottrell is about fifty per cent efficient. We are trying bag filters, Sonic Precipitators, and wet spray, or sludge collection, to supplement or replace the Cottrell.

Competition from the pipe lines for available gas has produced an enormous increase in gas costs in recent years. Realizing that increasing prices increases our vulnerability to competition from other types of pigment, the Carbon Black industry is vigorously searching for improvement in their methods.

## COLOR THROUGH THE AGES\*

By GEORGE FEARNLEY

International Paints (Canada) Limited

**Color:** It is everywhere. Without it life would be very drab, but, what is it? As we go through our daily life we come in contact with color every minute of the day. Try, if you can, to visualize a world without color. Everything we see would be in varying shades of gray. True, we would have beauty of form and shape, we would also have the chiaroscuro effect of light and shadow, but, there would be an over-all drabness. This drabness would have a very depressing effect on our emotions. Add color to the scene and we have that aesthetic beauty that has been with us since there was light. Color to the human emotions is like the spice which turns the insipid meal into the gastronomical treat.

We are so accustomed to seeing color everywhere that very few of us take time to find out what color is and how it affects our daily lives. The medical profession, particularly the psychologists, are finding uses for color in healing the sick, and as time goes on more and more will be

heard of the value of this attribute which we call color. Yet, what is it?

Color is light. It is that attribute which enables us to distinguish one object from another irrespective of shape or form. Light is the visible portion of the electromagnetic spectrum. The electromagnetic spectrum can be divided into some seventy octaves, from cosmic rays to radio waves. One octave of this spectrum constitutes visible light. It consists of that portion covering wavelengths from 380 to 720 millimicrons. These are radiations of varying frequency or different quanta depending on whether we use the wave theory of light or the quantum theory of matter. Neither of which fully explains the nature of light and consequently that of color. For our discussion on color and its effect on humanity we shall regard it as being a series of light waves of varying length or frequency.

When white light is passed through a prism, or for that matter, from any one substance to another substance which differs from it in density, the light is bent or refracted. As the light is

\* Presented before the Montreal Paint and Varnish Production Club, December, 1947.

composed of varying wave-lengths these are bent to a greater or lesser degree. As a general rule, the shorter the wave-length the greater the bending. Hence, it is possible to split the light into a band depicting its various wave-lengths. These various wave-lengths each have their own distinctive color. The shortest wave-lengths are violet and the longest red. We have all seen that beautiful spectacle called the rainbow. This is nothing more than the refraction of the light of the sun, passing from air through the denser medium, water, causing the splitting up of the light into its different components. Therefore color is nothing more nor less than portions of the visible portion of the electromagnetic spectrum.

If an object is viewed in what we may call white light not all of that light will be reflected. A certain portion of the light impinging on the surface of the object will be absorbed, a portion reflected and should the object be transparent the balance will be transmitted. Take clear glass, for instance, light striking the glass is not all transmitted. Depending on the angle of which the light strikes the glass a greater or lesser amount will be reflected, a small percentage will be absorbed and the balance transmitted. If the glass is colored a much greater proportion will be absorbed and the balance transmitted. If the glass is colored a much greater proportion of the incident light will be absorbed with a resulting lower amount being transmitted.

Any colored object behaves in the same way. If it is opaque, however, none of the light will be transmitted, and the color will be obtained by reflection of a portion of the incident light the balance being absorbed. For instance, if we see an object as a brilliant red, that object has absorbed the blue, green and yellow portions of the light striking it, leaving nothing but the red portion to be reflected giving the object its color. If an object is very pale in color a large amount of white light is also reflected together with the color of the object. This means that only a small portion of the incident light is absorbed. Similarly dark objects ab-

sorb greater amounts of the incident light and reflect only a small percentage of those wave-lengths giving the object its color.

Color is not something new, it has been with us since time first began. The cave men used color to brighten up their dwellings; they used the different colored earths to make their crude drawings and for painting their bodies. The early Greek philosophers were acquainted with mirrors and postulated their theories of optics but the earliest reference that can be found correlating color and light is that of Ptolemy in 150 A.D. He was the first person to state that a ray of light passing to a denser medium is bent. We do not find any further references to color until the middle of the seventeenth century, although around the fifteenth century we find evidence that people were becoming color conscious, and were using it to beautify their environments. Color



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was used then to express the mysteries of life rather than for artistic beauty. The symbolism of color can be found in the early history of many people. This is particularly true of the Indian tribes, where the tattooing on their bodies, and the colors on their masks and effigies were full of meaning and not necessarily artistic.

Prior to the seventeenth century there had been many painters who had used color to express their thoughts and help sway the feelings of individuals by the judicious use of the blending of color, but, there had been practically no advancement in our knowledge of the scientific aspect of color. It was left for such men as Boyle, Newton, Huygens, Waller, and Locke to put color on a scientific basis.

Boyle collected all the data which he could find on color, correlated and dissected it, added to it results of his own experimental work and published some of the earliest reports that are to be found. Newton, however, really started the serious work on color. The story goes that while attending the Stourbridge Fair in 1666 he purchased a prism and with it was successful in obtaining the first good image of the spectrum. His findings were very sharply criticised but were later confirmed by other workers. Huygens is credited with discovering the wave-theory of light although Hooke had suggested a similar theory a few years earlier. This discovery of the wave-theory of light following so closely behind Newton's discovery of the spectrum, led Waller in 1689 to produce what was, perhaps, the first color map or system of color designation. He used a chess board, placing the pure hues along the edges and mixtures of these hues going towards the center. From this time on rapid strides were made in the scientific aspect of color.

Meyer, a mathematician of Gothenburg, in 1745 produced three fundamental colors, yellow, red, and blue and various mixtures of these three. The three fundamental colors were placed at the corners of a triangle, binary mixtures formed the sides of the triangle, while tertiary mixtures were placed within the triangle. Meyer also prepared triangles of black, white and gray although he did not correlate these with the color triangle. Much work was done on these triangles by such workers as Litchenberg, Lambert, Runge, and Chevreul. After Meyer's death Thomas Young, a doctor, treated color from a physiological point of view and proposed the undulatory theory of light and put forward the hypothesis that color perception depends on the presence in the retina of these color receptors in the form of nerve fiber, sensitive to red, green and violet. Young's hypothesis was further developed by Helmholtz and the modifications became known as the Young-Helmholtz theory which covered the principles of color vision. Helmholtz also postulated causes of color blindness.

Runge who had worked on Meyer's color mixtures extended them and proposed a color solid

with the hues around the equatorial circumference and black and white at opposite poles. This was the forerunner of the color solids which are at present in use. Maxwell took up the study of the Young-Helmholtz theory of color perception and developed the Maxwell color disks by means of which when spun at a definite speed any color can be matched. These disks or modifications of them are still in use today. Maxwell also gave his name to the Maxwell Color Triangle which was similar to that of Meyer, and forms the basis of the uniform-chromaticity-scale system. Later workers suggested modifications of the Maxwell Triangle but some of these were short-lived. In the latter part of the nineteenth century theories of color vision and color designation were very common but these have given place to the newer theories.

At the turn of the present century Munsell designed his color solid. Munsell was an artist and the story goes that he was unable to note all the colors of a particularly beautiful sunset due to the rapid changes in color. As a result he evolved his color solid which has been widely accepted. The hues, five in number, together with five intermediate hues are placed around the periphery of an irregular shaped globe, the vertical axis of which forms a gray scale, black at the bottom and white at the top. This gray scale is arbitrarily divided into ten steps known as "value" steps, and are numbered from the bottom up to white (10) at the top. At each value step the hues extend out to the periphery in increasing degrees of chroma. So in the Munsell globe we have a system of designating each component color of the solid. When referring to color within the solid the hue is mentioned first, then the value and finally the chroma. For example to designate a red half way up the value scale and not fully saturated, R. 5/10, would mean that the hue was red, the value five and the chroma ten. The Munsell solid is not completed and can be added to from time to time as new colorants are developed.

Following closely behind the Munsell Solid came the Ostwald Solid. Ostwald concentrated on his study of color during the first world war, and made his solid complete. It consists of two cones placed base to base, with a gray scale for the axis and the twenty-four hues forming the equatorial circumferences. According to Ostwald there is no such thing as a pure color and all the colors in his solid contain a definite percentage of white and black. The colors which ascend towards white from the circumference are called tints, those which descend towards the black are called shades and those which have a uniform black and white content but varying color content are called tones. The Ostwald color solid is used extensively by psychologists and advertising men as it is simple to use when studying color harmony.

In 1931 at Cambridge in England an International Committee on Illumination met to try to evaluate these various theories which had been

expounded in order to find some ways and means of standardizing color designation. From this meeting came the I. C. I. standard observers and illuminants which have been adopted internationally. Data on color today are usually referred to the I. C. I. standard observer. Trichromatic coefficients were worked out for the whole of the visible spectrum at five millimicron intervals. I. C. I. color mixture diagram consists of a two dimensional color map. The co-ordinates or trichromatic coefficients are those defined in 1931 and total one, therefore plotting any two will give the location of a color, "x" and "y" are the two most commonly used. Further to these trichromatic coefficients the diffuse reflectance relative to magnesium dioxide is also determined. This is designated as "y." This is an indication of the value or brightness of the color. The I. C. I. method of color designation is being included in many specifications.

Workers today are still trying to solve all the mysteries of color and many new systems of designation and determination of small color differences are being worked out. Many of these improvements are for specific purposes and can be correlated to the I. C. I. system. Scofield, Judd, and Hunter have worked out equations to give measures of chromaticity which are more closely related to the visual estimates of opaque surfaces than the I. C. I. designations. These can be calculated from I. C. I. plots. Jacobson has found that the I. C. I. chromaticity diagram is not satisfactory for defining the whiteness of titanium dioxide. These modifications are proof that color science is still advancing.

There are two methods of obtaining color mixtures with reference to light. They are the additive method and the subtractive. The additive method, as the name implies, consists of mixing portions of the spectrum to obtain the whole. For example, if we take light from three different sources, one of which is green, one red, and the other blue and mix these three light beams we shall obtain white light, where the green and red mix we shall obtain yellow, red and blue will give magenta

and green and blue will give cyan. This method consists of taking away a portion of the white light to give the required color. The subtractive method of color mixture is what we are accustomed to in our daily life, when white light strikes an object a portion of the light is absorbed, the balance being reflected. This reflected portion gives the object its color.

These methods of color mixture have led to some confusion as to what are primary colors. The physicist, who deals with light as color, and bases practically all his work on the additive method of color mixture uses blue, green and red as the three primary colors. Artists, on the other hand, and along with them the majority of people who use color, call blue, yellow, and red the three primary colors. These are based on the subtractive method of color mixture. Psychologists, however, not wanting to enter into any controversies and deal-

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ing with color from a visual point of view, consider red, green, yellow, blue, black, and white as primaries. All of these are correct and the variations are due to the different methods of making color mixtures or the medium in which they are used.

Environment plays an important part in color. The same color seen on varying backgrounds will appear to be quite different. If we superimpose a color, say yellow, on different colored backgrounds the apparent color and the size of the yellow object will change. It will appear brighter on the darker backgrounds and darker on the light backgrounds. The eye accommodates itself to variations very readily and does not always see the true color. Another aspect of color which is found in visual observations of strong colors, is that after looking at a strong color for a length of time and then suddenly looking away, the object will be seen in its complimentary color. This is due to the fatigue of the receptors of the eye for the particular color which has been observed, the balance of the receptors being un-fatigued transmit to the brain their stimulation when the color before the eye is changed.

Somewhat similar to this, although not actually identical, is the fact that an object illuminated by a colored light will cast a shadow whose color will not be black but the complimentary of the color of the illuminant. A keen observer can pick out these colored shadows in nature, particularly in the late evening.

When either the Munsell or the Ostwald Solids are split vertically we obtain complimentary colors on either side of the gray scale. These complimentary colors occur in varying values and chroma. If we split the solids horizontally we have constant value with varying chroma for the whole of the hue circle. These two ways of splitting the color solids form a basis for studying color harmony. Good harmony can always be obtained by keeping one of the three components of the color solid constant. That is to say, if we keep hue constant, and vary the value and chroma a very pleasant color harmony can be obtained. Similarly, if we keep either the value or chroma constant varying the other and the hue another type of pleasing harmony will result.

Studying our hue circle we find that those colors which are directly opposite each other are complimentary to each other. These colors can be used in pairs to give complimentary harmony. Care has to be taken, however, when using complimentary colors that the two are not used in equal chroma and value. One of them must be subdued to the other. If this is not done the colors will vibrate with each other for prominence and the effect will be very hard on the nervous system. When we divide the circle into three equal portions, the hues at these points form a triad. These three colors when mixed together will give gray. Besides the triads we can use adjacent

colors in varying chroma and value and what is known as split complimentaries.

If we have contrasting colors that seem to vibrate or clash with one another we can achieve harmony and reduce this harsh appearance by incorporating a small amount of color which is intermediate between the two. This will tie the two contrasting colors together. Another common method is to use a background color which has a lower value than either of the other contrasting colors but which is adjacent to one of them. The classic painters used this method quite successfully. Brown being the most commonly used color for this effect.

In some harmonious color combinations small amounts of contrasting colors add spice to the arrangement. These bright high chroma colors are tolerated in the harmonious whole by keeping the area they occupy so small that they do not clash but help to improve the brilliancy of the color scheme. This can be achieved in a room by flowered draperies, carpets or if the room is painted by a small line of a bright color.

To sum up we have basically three forms of color harmony all of which can be obtained from one color solid. They are, adjacents or similar hues, complimentary or contrasting colors and triangle or triads. We may also conclude that any two colors can be used to obtain harmony, so long as we remember the principle of induced complimentaries, equal areas and color balance. Colors when seen in different environments appear to be quite different from when seen alone. Different backgrounds can subdue or enhance bright or drab colors depending on what effect is required.

Color harmony is playing a very important part in our lives today, whether we realize it or not. It is being used as a safety measure in many factories and the judicious selection of colors for machinery has been responsible for the reduction of fatigue. Similarly, color is playing a very important part in hospitals. No longer do we see new hospitals all white or pale green. Different rooms are painted in different colors depending on the location of the rooms. Some authorities even claim that certain colors can restore health to convalescents much quicker than other colors. In maternity wards warm tones of ivory and flesh are used as these stimulate optimism and cheerfulness, while in rooms of chronic patients, blues and greens are used as these offer a more relaxing atmosphere. Operating rooms are painted in a blue green, to reduce glare, and offer visual relaxation to the surgeon, blue green being complimentary of the red color of blood and tissue.

A knowledge of color and color harmony can help everyone to obtain greater enjoyment out of life and in doing so improve the human race.

## NEWS AND REVIEWS

An up-to-date list of standard samples issued or in preparation by the National Bureau of Standards is now available from the Bureau's Publication Section. The Bureau now issues more than 400 different kinds of standard samples, comprising materials of certified composition such as metals, ores, and ceramics; high-purity hydrocarbons; certain high-purity chemicals; paint pigments for color; oils for viscometer calibrations; melting-point standards; radioactive materials; and a number of reference standards, such as lamp, opacity, and reflectance standards.

These standards have been established during the past 40 years to meet the constantly increasing needs of industrial and research laboratories. They now have a wide distribution; in fact, about 22,000 individual samples were sold during the past fiscal year. Representative uses of the Bureau's standard samples include the checking of chemical and instrumental methods of analysis; developing new methods of analysis; calibration of spectrometers, spectrographs, pH meters, calorimeters, pyrometers, and polarimeters; establishment of uniformity in test methods; and settling and avoiding of disputes between buyers and sellers.

Supplement to National Bureau of Standards Circular 398, *Standard Samples Issued or in Preparation by the National Bureau of Standards*: 19 large-sized pages; containing a schedule of fees, unit weights, directions for ordering, and other information; can be obtained free upon request from the Publications Section, National Bureau of Standards, Washington 25, D. C.

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Revised charts listing available Hercules Powder Company synthetic resins and their properties are now available. One chart lists synthetic resin solutions only and the other includes resins available in solid and solution form.

Information on the charts, which are 8½" x 11", includes trade names of the resins, brief chemical descriptions,

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and typical test data such as acid number, color, softening point, and viscosity ratings.

Dr. Otto Eisenschiml, president, Scientific Oil Compounding Company, will receive the Honor Scroll Award of the American Institute of Chemists at a meeting of the Chicago Chapter on October 7, 1949. Dr. Eisenschiml is being honored for his outstanding work in the chemistry of vegetable oils and his untiring efforts in promoting the professional prestige of the chemist.

Dr. Eisenschiml is also widely known as a historian and author. His books include "Why Was Lincoln Murdered?" "As Luck Would Have It," "Without Fame" and many others.

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## RECENT ADVANCES IN PAINT TECHNOLOGY

**GAS ADSORPTION AS A PRINTING INK RESEARCH-TOOL.** A discussion of recent work on the use of gas adsorption in determining the extent and nature of pigment surface which have been found to have a large influence on the flow properties and printability of printing inks. The so-called BET theory (Brunauer, Emmet and Teller) relating to the adsorption of gases on solids was shown to be helpful in arriving at explanations of the different behaviours of varieties of pigments which were indistinguishable by other methods. A diagram of the BET apparatus used, and some of the plots of adsorption isotherms of pigments are illustrated. A. C. Zettlemoyer. Am. Ink Maker **26**, No. 1, 25-27, 59 (January, 1948).

**ASSESSMENT OF SHIPS' PAINTS USED IN THE BRITISH NAVY.** This paper presents considerable material on the various types of paints used in marine work. The discussion takes up anti-corrosive paints for ships' bottoms (preparation of surface, types of protective paints, electrochemical aspect, assessment, raft trials, ship trials and laboratory tests), antifouling paints for use on ships' bottoms (antifouling measures, anti-fouling mechanism, practical assessment, leaching rate and chemical examination), weatherwork paints (marine chalking, practical and laboratory assessments), fire-retardant paints, deck paints (interior deck-paints, weather-deck paints for use over steel), anticondensation paints (tests for color, efficiency, ease of application, neutrality of condensate, minimum combustibility, adhesion of the anticondensation agent). Photographs of many tests and testing apparatus are shown. Several pages of discussion follow. Seventeen references. C. D. Lawrence and G. E. Gale. Jour. Oil & Colour Chemists Assn. **30**, 519-556 (1947).

**PRESENT TRENDS IN OIL-MODIFIED ALKYD RESINS.** Some of the more recently available polyhydric alcohols used as alternatives for glycerol, and polybasic carboxylic acids and their influence on the properties of glycerides and modified alkyd resins prepared from them are discussed. Of the polyalcohols covered (pentaerythritol, dipentaerythritol, mannitol, sorbitol, xylitol and ethyltrimethylolmethane), the first is especially considered. Maleic anhydride, terpene-maleic adducts, cyclopentadiene-maleic anhydride adduct and methylenedisalicylic acid are discussed. Twenty-six references. E. O. Phillips. Chemistry & Industry **1948**, No. 1, 3-5.

**PHTHALOCYANINE COLORS.** The development and uses of phthalocyanine colors in various uses (e. g. trichromatic printing, printing inks) is traced; the porphyrazines and metal derivatives of phthalocyanines and technical evaluations of these colors are discussed. Nine references. A. H. Woodhead. Paint Manuf. **17**, 369-372 (1947).

**ALUMINUM FLAKE POWDERS.** Many of the qualities of aluminum flake powders and the relationship of these qualities to the properties of the powders when used as pigments, as well as the dimensional properties and their relationships to the method of manufacture of the powders are discussed. Methods for determining the velocity of sedimentation, the covering power and leafing power and the properties of non-leaving aluminum powders are described. The effects of method of manufacture (ball-milled or stamped powders in either methylated spirit or benzene) on covering power and average thickness are shown graphically and sedimentation characteristics of various aluminum powders are compared. Ten references. G. W. Wenden. Paint Manuf. **17**, 373-379 (1947).

**METALLIC PIGMENTS.** The results of an investigation carried out by the Corrosion Committee of the British Iron and Steel Inst. on the electrolytic functions of metallic pigments in protective paints are discussed. In the cathodic or sacrificial protection of iron and steel in which the ferrous metal is protected at the expense of a less noble metal which is in electrolytic contact with it, it was found that cathodic protection was afforded by only zinc dust in paints, since aluminum pigment and magnesium dust in paints do not fulfill the necessary condition of metallic contact through the interposition of a non-conducting oxide skin. The electrode potential of cathodic and anodic pigments, the measurement of electrical contact and of electrode potential and the metallic contact between pigment particles incorporated in paint are discussed. J. E. O. Mayne. Paint Manuf. **17**, 380-382 (1947).

**ZINC AS AN ANTI-CORROSION.** As one of the recent approaches to the old problem of corrosion of ferrous metals, zinc and its compounds have met with some success. This article opens with a review of the phenomenon of ferrous corrosion and presents an account of the possible mechanism by which zinc functions as an anti-corrosive pigment. The importance of pH values and of purity are discussed. A. H. Stuart. Paint Manuf. **17**, 383-385 (1947).

**TITANIUM PIGMENTS.** A brief review of recent advances in the titanium pigment industry is given, and the essential features of titanium oxide pigments are recapitulated. M. Schofield. Paint Manuf. **17**, 386-388 (1947).

**ELECTROLYTIC PRODUCTION OF CHROME YELLOW.** This method of chrome yellow manufacture has been discussed only briefly in the literature. It is not widely used because the process is complicated and necessitates unremitting attention of both chemist and electrical engineer, and there is not the same flexibility for changing the tint and shade through the wide range of sulfur yellows, pale yellows, dark yel-

lows and orange chromes which is common to the traditional chemical precipitation methods. The main chemical reactions, operation of the process and importance of chemical supervision are pointed out. C. C. Downie. Paint Manuf. 17, 388-390 (1947).

**TROPICAL PAINTS.** The durability of paints in the tropics, defects of paints in the tropics, mold growth and assessment of tests methods of these paints are discussed. H. B. Footner and G. Murray. Paint Tech. 12, 169-171 (discussion 171-2) (1947).

**PAINTS IN RAILWAY SERVICE.** Painting problems and factors influencing choice of paints for specific purposes in this field are discussed. Surface preparations, methods of application, factors affecting choice of process, conditions of service, maintenance, interior finishing, finishing of structures, cleaning, type tests and routine tests, development tests, opacity and fundamental studies are individually taken up. F. G. Dunkley and D. P. Earp. Paint Tech. 12, 173-176 (1947).

**PERFORMANCE TESTING OF PAINTS.** Particular attention is paid to tests with a bearing on ultimate outdoor durability, and a classification of tests, measurements of hardness, of adhesion, of flexibility or distensibility, of water-vapor permeability and accelerated weathering are discussed. H. Hollis. Paint Tech. 12, 177-181 (1947).

**PAINTS FOR AUTOMOBILES.** Papers given at the Muxton Conference of the Oil and Colour Chemists' Assoc. are discussed. E. W. Plowman spoke of the surface to be treated, the painting process, the speed of processing, after-treatment and show-room finish, retention of color and appearance and protective qualities of automobile paints. H. J. Mason brought out the importance of control of dipping paints and enamels, condition of finished work, characteristics of high-bake enamel systems, finished applied by spray, cellulose lacquers and synthetic enamels and

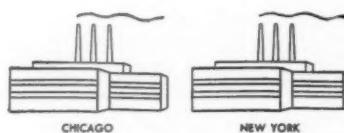
service tests. Discussion included. Paint Tech. 12, 205-212 (1947).

**AIRCRAFT FINISHES.** This paper brings out facts about the pretreatment of metal surfaces, specifications of the finishes for supported and unsupported fabrics and metal, requirements of the industry, assessment of performance, principal tests and recent developments. Discussion follows. R. J. Ledwith. Paint Tech. 12, 212-214 (1947).

**SHIP PAINTS.** The assessment and laboratory tests of anti-corrosive and anti-fouling paints for ships' bottoms, the leaching rate, chemical examination, weatherwork paints, marine chalking, fire-retardant paints, interior deck paints, weather-deck paints and anti-condensation paints are discussed. C. D. Lawrence and G. E. Gale. Paint Tech. 12, 215-222 (1947).



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## FOREIGN PATENT DEVELOPMENTS

**COATING COMPOSITIONS.** British Thomson Houston Co., Ltd. Brit. Pat. 590,680. Applied for March 17, 1943 (applied for in U. S. March 25, 1942); accepted July 25, 1947. Polymers of diallyl esters of aliphatic or aromatic dicarboxylic acids are mixed with another allyl ester which acts as a solvent and as an inhibitor against further polymerization of the diallyl ester, thus permitting the use of the diallyl polymers in varnishes for impregnating porous bodies such as cork, pottery, felts, or fabricated bodies with interstices such as netted fibers, or interwoven fibrous materials, and for coating metals other than copper, glass fibers, concrete, linoleum, or in the manufacture of laminated fibrous sheet materials. The plasticizing allyl esters include the propionate, butyrate, isobutyrate, valerate, isovalerate and the corresponding methallyl esters. The diallyl esters which may be used are the succinate, glutarate, adipate, isophthalate, naphthalate, oxalate, malonate and sebacate.

**COMPOSITION FOR CEMENT OR COATING.** W. Blackman and J. E. S. Whitney. Brit. Pat. 600,800. Applied for June 18, 1947; accepted April 19, 1948. A composition to provide a base for, or be used as, a cold-setting and/or air drying material is made by heating together rubber, a drying oil containing conjugated double bond (e.g. dehydrated castor oil), an acid-catalyzed non-heat-reactive phenol-aldehyde resin containing up to 20% of a heat-reactive, oil-soluble phenol-aldehyde resin (both made from a phenol which is para-substituted with an alkyl group having at least 3 C atoms—e.g. p-tertiary-amyl-cresol). The rubber is first blended with a major proportion of the acid-catalyzed resin containing all the heat-reactive resin, and this blend is then incorporated in a heated solution of the remainder of the phenolic resin in the drying oil, the duration and degree of heating being such the drying oil is neither pre-oxidized nor pre-polymerized beyond the point at which it is compatible with the pre-blended rubber-resin mixture. The mass is then heated until it acquires the desired consistency on cooling. These compositions are said to adhere well to the surfaces of molded synthetic resins, especially phenolic condensation products, and to metal such as steel, and may be used as coatings, adhesives or cements for sealing and retaining closures etc.

**COATING AND IMPREGNATING COMPOSITIONS.** The British Thomson-Houston Co., Ltd. Brit. Pat. 613,650. Applied for June 24, 1946 (applied for in U. S. June 26, 1945); accepted Dec. 1, 1948. A coating and impregnating composition suitable for laminating compositions and laminated products consists of a polymerizable diethylene glycol maleate, a polyester compatible therewith made by esterifying allyl alcohol with

a polycarboxylic acid (e.g. allyl phthalate polymer), a catalyst (e.g. benzoyl peroxide) for accelerating copolymerization of the ingredients, and a polyvinyl formal resin.

**PROCESS AND APPARATUS FOR LIQUID SPRAYING.** M. L. White and S. White. Brit. Pat. 614,475. Applied for June 13, 1946; accepted Dec. 16, 1948. A process for coating surfaces such as ceilings with media of more or less liquid character (whitewash, distemper etc.) which consists in projecting the media in finely divided state under pressure into a zone surrounded by another zone of lower pressure both of which communicate in close proximity to the surface to be sprayed to insure good distribution of the medium with abstraction of surplus through the established zone of pressure.

**COATING COMPOSITIONS.** Imperial Chemical Industries Ltd. Brit. Pat. 614,781. Applied for July 29, 1946; accepted Dec. 22, 1948. Coating compositions in which the resinous component is wholly or partly a polymer of 4-vinylcyclohexene are described. In a typical formula, polymerized 4-vinylcyclohexene is heated with raw linseed oil, and then thinned with mineral spirits and cobalt driers are added.

**ANTI-SWEAT COMPOSITION.** J. H. Donnelly. Brit. Pat. 615,541. Applied for Jan. 7, 1946; accepted Jan. 7, 1949. In a method of making a composition having useful anti-sweat properties, when applied to a surface and dried, a paint pigment is ground into an organic water-insoluble binder capable of taking up oxygen when exposed to air (e.g. drying oil-modified polyhydric alcohol-polybasic acid varnishes such as oil-modified glyceryl phthalate varnishes, oleo-resinous varnishes, phenolic resin varnishes or drying oils) and drying to form a tenacious film, the binder being in solution in a paint thinner. An emulsifier and water are then added so that the resulting mixture is a water-in-oil type emulsion, and an exfoliated micaceous material (e.g. vermiculite) is kneaded in. Such a paint is particularly designed for use in ships' interiors subject to bombing or fire where paints with large proportions of organic binders are hazardous.

**INTERPOLYMERS FOR USE IN COATING COMPOSITIONS.** W. T. C. Hammond and L. E. Wakeford (assigned to Lewis Berger & Sons). Brit. Pat. 616,044. Applied for Aug. 22, 1946; accepted Jan. 14, 1949. Aromatic vinyl hydrocarbons (styrene) are interpolymerized with a drying oil (e.g. alkali-refined linseed oil, dehydrated castor oil, China wood oil or mixed drying oil-stand oil) by heating in the presence of a small amount of sulfur to produce a material suited for use with conventional pigments, binders, etc. for coating compositions.

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## S ON TRACK

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